**3GPP TSG-RAN WG4 Meeting #94-e R4-2002515**

**Electronic Meeting, Feb.24th – Mar.6th 2020**

**Agenda item:** 7.11.4

**Source:** Moderator **(**Huawei, HiSilicon)

**Title:** Email discussion summary for RAN4#94e\_#86\_NB\_IOTenh3\_Demod (2nd round)

**Document for:** Information

# Introduction

During the last meeting, the work scope of performance part related with LTE Rel-16 WI additional enhancement for NB-IoT is discussed. The generally issue to identify the features that related BS and UE demodulation requirement is captured in WF R4-1915909.

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| --- |
| * UE * FFS whether to introduce the UE demodulation performance requirement(s) to verify the UE performance when NPDSCH configured with multiple TB scheduling   + No other UE demodulation requirements will be introduced * BS * FFS whether to introduce the BS demodulation performance requirement(s) to verify the following features * NPUSCH configured with multi-TB scheduling * Coexistence of NPUSCH and NR * When NB-IoT transmission is postponed by subframe(s) for NR UL transmission * No other BS demodulation requirements will be introduced |

*List of candidate target of email discussion for 1st round and 2nd round*

* 1st round: TBA
* 2nd round: TBA

# Topic #1: Multi-TB scheduling

*Main technical topic overview. The structure can be done based on sub-agenda basis.*

## Companies’ contributions summary

|  |  |  |  |
| --- | --- | --- | --- |
| **T-doc number** | **Title** | **Company** | **Proposals / Observations** |
| R4-2000312 | View on BS demodulation requirement for LTE additional enhancement for NB IoT | Samsung | **Observation 1: The interleaving granularity can be verified with valid-sub-frame configuration similarly**  **Proposal 1: No BS demodulation requirement for multi-TB scheduling.** |
| R4-2001353 | Open issues on UE/BS demodulation requirements for Rel-16 NB-IoT | Ericsson | **Proposal 1: RAN4 does not define new NPDSCH demodulation requirements with multi-TB scheduling.**  **Proposal 2: RAN4 does not define new NPUSCH format 1 demodulation requirements with multi-TB scheduling.** |
| R4-2001461 | Discussion on NPDSCH performance requirements for additional enhancements for NB-IOT | Huawei, HiSilicon | **Observation1: The longer the number of sub-frames sustained by TBs, the greater the interleaving gain.**  **Proposal 1: Define the performance requirement of multi-TB with interleaving.**  **Proposal 2: Use the simulation assumptions in Table 3 for multi-TB with interleaving performance requirements definition.**  **Table 3: Simulation assumptions**   |  |  | | --- | --- | | **Parameter** | **Value** | | Duplex mode | FDD/TDD | | System bandwidth | 180 kHz | | Carrier frequency | 900 MHz | | Operation mode | Stand alone | | Antenna configuration | 1T1R | | Channel model | TU 1Hz | | Frequency error | 0 Hz | | Timing error | 0μs | | NSF | 5 | | Repetition number | 32 | | Performance target | SNR@75% of maximum throughput | | Channel estimation | Realistic cross-subframe channel estimation | |
| R4-2001462 | Discussion on NPUSCH performance requirements for additional enhancements for NB-IOT | Huawei, HiSilicon | **Observation 1: The throughput of interleaved transmission is greater than the throughput of continuous transmission.**  **Observation 2: The gain of interleaved transmission can reach up to 1.28dB when the number of sub-frames occupied by one TB is 320.**  **Observation 3: The longer the number of sub-frames sustained by TBs, the greater the interleaving gain.**  **Proposal 1: Define the performance requirement of multi-TB with interleaving for Rel-16 NPUSCH.**  **Proposal 3: The parameters listed in Table 3 copied from Table 8.5.1.1.1-3 in TS 36.104 can be chosen to tested Rel-16 NPUSCH transmitted interleaved performance and the number of HARQ processes should be set to 2.**  **Table 3: Simulation assumptions**   |  |  | | --- | --- | | **Parameter** | **Value** | | Number of tones | 12 | | SCS | 15kHz | | Antenna configuration | 1T1R | | Channel model | ETU 1Hz | | Frequency error | 0Hz | | Timing error | 0μs | | *N*RU | 10 | | Repetition number | 32 | | Performance target | SNR@ 70% of maximum throughput | |
| R4-2001916 | UE and BS demodulation requirements for NB\_IOTenh3 | Nokia, Nokia Shanghai Bell | **Observation 1: For multi-TB scheduling, the performance benefit can be reasoned by increased time diversity of the radio channel rather than refinements to PHY layer reception.**   1. No separate UE / BS demodulation requirements are required for multi-TB scheduling for NPDSCH / NPUSCH. |

## Open issues summary

*Before e-Meeting, moderators shall summarize list of open issues, candidate options and possible WF (if applicable) based on companies’ contributions.*

### Sub-topic 1-1: NPDSCH performance requirement(s) with multi-TB scheduling

*Sub-topic description:*

*As per the approved WF R4-1915909 in RAN4#93 meeting:*

* *UE*
* *FFS whether to introduce the UE demodulation performance requirement(s) to verify the UE performance when NPDSCH configured with multiple TB scheduling*

*Open issues and candidate options before e-meeting:*

**Issue 1-1: Whether to introduce NPDSCH performance requirements with multiple TB scheduling**

* Proposals
  + Option 1: Yes (Huawei)
  + Option 2: No (Ericsson, Nokia)
* Recommended WF
  + TBA

### Sub-topic 1-2: NPUSCH performance requirement(s) with multi-TB scheduling

*Sub-topic description*

*As per the approved WF R4-1915909 in RAN4#93 meeting:*

* *BS*
* *FFS whether to introduce the BS demodulation performance requirement(s) to verify the following features*
* *NPUSCH configured with multi-TB scheduling*

*Open issues and candidate options before e-meeting:*

**Issue 1-2: Whether to introduce NPUSCH performance requirements with multiple TB scheduling**

* Proposals
  + Option 1: Yes (Huawei)
  + Option 2: No (Samsung, Ericsson, Nokia)
* Recommended WF
  + TBA

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Qualcomm | Sub topic 1-1: We support option 2.  Sub topic 1-2: |
| Huawei | Sub topic 1-1: Multi-TB with interleaving has provide great performance gain based on our simulation results as shown in R4- 2001461.  Sub topic 1-2: The HARQ process number has been changed and great performance gain for multi-TB with interleaving has been shown in our contribution R4-2001462 |
| Samsung | Sub topic 1-2: We support option 2.  Multi-TB with interleaving is eNB configured feature. Up to 2 TB scheduling is supported, the diversity gain is limited.  LTE NB-IoT has already supported similar non-continuously transmission, with postponed operation in case overlapping resource reserved or UL gap in case of large number of repetition. For each TB transmission, the demodulation requirement can be verified by existing requirement with valid-subframe configuration in FDD and UL-DL configuration in TDD, there is no impact on the BS receiver processing. |
| Ericsson | Sub topic 1-1: We prefer option 2. We don’t see the motivation to define new NPDSCH demodulation requirements with multi-TB transmission. Since UE continuously receives the channel from the same BS, UE demodulation algorithm should be same regardless 2 TBs are transmitted with interleaved or not.  Sub topic 1-2: We prefer option 2. Similar to 1-1, we don’t see any motivation to define new NPUSCH format 1 demodulation requirements with multi-TB transmission. Since BS continuously receives the channel from the same UE, BS demodulation algorithm should be same regardless 2 TBs are transmitted with interleaved or not. |
| Nokia | Sub topic 1-1: We support option 2. Major performance gain is achieved by increased time diversity of the channel. On R4-2001461, it appears the curve for 32 repetitions for non-interleaved transmission in Fig.2 would never meet the maximum TP, even for very good SNR, we wonder on the reason for that.  Sub topic 1-2: We support option 2. In our view the performance gain is limited and originates from increased time diversity of the channel. In R4-2001462 the maximum number of RU’s (10) and a high number of repetitions (32) must be configured to achieve a gain of little more than 1 dB, which cannot be observed for many other configurations. |

### CRs/TPs comments collection

*Major close-to-finalize WIs and Rel-15 maintenance, comments collections can be arranged for TPs and CRs. For Rel-16 on-going WIs, suggest to focus on open issues discussion on 1st round.*

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| XXX | Company A |
| Company B |
|  |
| YYY | Company A |
| Company B |
|  |

## Summary for 1st round

### Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*

|  |  |
| --- | --- |
|  | **Status summary** |
| **Sub-topic#1-1** | *Tentative agreements:*  *Candidate options:*  *Whether to introduce NPDSCH performance requirements with multiple TB scheduling*   * + Option 1: Yes (Huawei)   + Option 2: No (Ericsson, Nokia, Qualcomm)   *Recommendations for 2nd round: Continue to discuss about whether to introduce NPDSCH performance requirements with multiple TB scheduling* |
| **Sub-topic#1-2** | *Tentative agreements:*  *Candidate options:*  *Whether to introduce NPUSCH performance requirements with multiple TB scheduling*   * + Option 1: Yes (Huawei)   + Option 2: No (Ericsson, Nokia, Samsung)   *Recommendations for 2nd round: Continue to discuss about whether to introduce NPUSCH performance requirements with multiple TB scheduling* |

*Recommendations on WF/LS assignment*

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| --- | --- | --- |
|  | **WF/LS t-doc Title** | **Assigned Company,**  **WF or LS lead** |
| #1 | Way forward on LTE UE and BS performance requirements for additional enhancements for NB-IOT | Huawei, HiSilicon |

### CRs/TPs

*Moderator tries to summarize discussion status for 1st round and provides recommendation on CRs/TPs Status update*

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| --- | --- |
| **CR/TP number** | **CRs/TPs Status update recommendation** |
| XXX | *Based on 1st round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

## Discussion on 2nd round

### Open issues summary

**Issue 1: Whether to introduce NPDSCH performance requirements with multi-TB scheduling**

* Proposals
  + Option 1: Yes
  + Option 2: No
* Recommended WF
  + TBA

**Issue 2: Whether to introduce NPUSCH performance requirements with multi-TB scheduling**

* Proposals
  + Option 1: Yes
  + Option 2: No
* Recommended WF
  + TBA

### Companies’ view collection for 2nd round

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| --- | --- |
| **Company** | **Comments** |
| Ericsson | Issue 1: In our understanding, RAN1 designed the multi-TB transmission with few modifications as possible to the receiver algorithm regardless of interleaved or not.  Moreover as we argued in #85 eMTC5 Demod, WI objective in RP-193224 indicates only RAN1/RAN2 as the involved WGs. In our understanding RAN4 indication in the core part WI objective concerned both RAN4 core work and RAN4 performance work.   |  | | --- | | 1. **Scheduling enhancement:**  * Specify scheduling multiple DL/UL transport blocks with single DCI for SC-PTM and unicast [RAN1, RAN2] |   Therefore we would like to stick to Option 2, no new NPUSCH/NPDSCH demodulation requirements with the multi-TB transmissions regardless of interleaved or not.  Issue 2: We prefer Option 2 as the same reason as Issue 1  [2020-03-04]  To Huawei, when Rel-14 introduced 2 HARQ processes for NPUSCH format 1, RAN4#82bis had the following agreement:   * No additional demodulation performance requirements for NPUSCH format 1 with 2 HARQ processes and/or larger TBS need to be defined.   We don’t understand why RAN4 needs new performance requirements due to 2 HARQ processes now. |
| Qualcomm | Sub topic 1-1: We share the same view as Ericsson. Multi-TB transmission has no impact on PHY layer behavior of UE. RAN4’s mandate is not to quantify the gain of multi-TB transmission due to timing diversity. This was already done by RAN1 during the WI. We support option 2. Also, the decision in this thread should be aligned with the decision on the similar topic in email discussion #85 for eMTC. |
| Huawei | Issue 1: We support option1: The performance gain can be 2.68dB when *N*SF=5, *N*Rep=32, the gain is very obvious. With more sub-frames and increased number of repetition scheduled, the gain will be greater. The obvious performance gain achieved by multi-TB scheduling cannot be ignored.  To Nokia: As you indicated, the results show that interleaved transmission can reach the maximum throughput but non-interleaved transmission can’t from our simulation results, this further demonstrates that we need to define the performance of interleaved transmission.  To Ericsson: RAN4 should work on performance specifications emphasized in RP-193224:  C:\Users\l00502554\AppData\Roaming\eSpace_Desktop\UserData\l00502554\imagefiles\6A9B059E-0DBF-44FD-B9C0-A150C7898321.png  Multi-TB with interleaved transimisson is necessary performance requirement as we previously analyzed.  Issue 2: We support option1.  To Ericsson: The number of HARQ processes has been changed, two soft buffers are configured compared to one in previous NPUSCH, demodulation algorithm has been changed.  To Nokia: NPUSCH with interleaving has less gain than NPDSCH but the gain is still obvious, we can increase the RUs scheduled and repetition numbers to increase the gain. Additionally the number of HARQ process is changed to 2, this is a new feature that we should consider.  To Samsung: UL gap and valid-subframe configuration is not used in Rel-13 and Rel-14 NPUSCH performance requirements, it has been verified that NPUSCH performance is same for TDD and FDD, so the time diversity gain that can achieved by TDD UL-DL configuration in TDD is limited. |
| Samsung | To Huawei:  RAN1#84bis agreements:  Post adhoc#2 email agreements:   * Introduce uplink transmission gaps for long uplink (i.e. NB-PUSCH/NB-PRACH) transmissions.   + During uplink transmission gaps, the UE may switch to the DL and performs time/frequency synchronization   For any NPUSCH transmission with duration greater than X ms, a final UL gap of duration Y is inserted at the end of the NPUSCH transmission:  This is RAN1 feature in Rel-13 about UL gap, when the repetition of NPUSCH transmission is very large, there is gap between NPUSCH transmissions. Meanwhile, if srs-SubframeConfig is broadcasts  For multi-tone transmission with repetition, puncturing is used to transmit NB-PUSCH.  In that sense, UE cannot support continues transmission.  Similar with the not-continues transmission and UL gap, multi-TB is related with scheduling issue.  Only up to 2 TB supported, the gain is limited, which can be achieved with frequency hopping  Normally BS will process per slot and combine the multi slots signal within TB, regarding of interleaved or not, there is no different for receiver processing.  As mentioned, two soft buffers needed, while for each TB within each buffer, in terms of demodulation performance for each TB, each TB with combination operation is expected with similar performance. |
| Nokia | Issue 1: We share the views of Ericsson and Qualcomm. We support option 2. We don’t see RAN4 being included for the scheduling enhancement feature in the latest WID in RP-193224. This means that the leading WG RAN1 with primary responsibility has consensus not to include RAN4 for this feature in order to specify performance requirements. The aspect mentioned by Huawei above, about content of 4.2 in the WID, this is related to features for which RAN4’s secondary responsibility has been added in the WID.  Issue 2: We share the views of Ericsson and Samsung. We support option 2. The same reasoning as for issue 1 applies. |

## Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

|  |  |
| --- | --- |
| **CR/TP/LS/WF number** | **T-doc Status update recommendation** |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

# Topic #2: Coexistense of NPUSCH and NR

*Main technical topic overview. The structure can be done based on sub-agenda basis.*

## Companies’ contributions summary

|  |  |  |  |
| --- | --- | --- | --- |
| **T-doc number** | **Title** | **Company** | **Proposals / Observations** |
| R4-2000312 | View on BS demodulation requirement for LTE additional enhancement for NB IoT | Samsung | **Proposal 2: No new BS demodulation requirement for coexistence of PUSCH and NR.** |
| R4-2001353 | Open issues on UE/BS demodulation requirements for Rel-16 NB-IoT | Ericsson | **Proposal 3: RAN4 discuss whether to define new NPUSCH demodulation requirements in the case of slot-level resource reservation.** |
| R4-2001462 | Discussion on NPUSCH performance requirements for additional enhancements for NB-IOT | Huawei, HiSilicon | **Proposal 2: No need to define the performance requirements for coexistence of NPUSCH and NR.** |
| R4-2001916 | UE and BS demodulation requirements for NB\_IOTenh3 | Nokia, Nokia Shanghai Bell | **Observation 2: For postponed NB-IoT UL transmissions, due to subframe-level reserved resources for NR, any performance impact can be reasoned by increased time diversity of the radio channel.**  **Proposal 2: No separate BS demodulation requirements for NPUSCH are required for coexistence of NB-IoT with NR.** |

## Open issues summary

*Before e-Meeting, moderators shall summarize list of open issues, candidate options and possible WF (if applicable) based on companies’ contributions.*

### Sub-topic 1-1: NPUSCH performance requirements for coexistence of NPUSCH and NR

*Sub-topic description:*

* *BS*
* *FFS whether to introduce the BS demodulation performance requirement(s) to verify the following features*
* *Coexistence of NPUSCH and NR*
* *When NB-IoT transmission is postponed by subframe(s) for NR UL transmission*

*Open issues and candidate options before e-meeting:*

**Issue 1-1: Whether to introduce BS demodulation requirements for coexistence of NPUSCH and NR**

* Proposals
  + Option 1: Further discuss whether to define new NPUSCH demodulation requirements in case of slot-level resource reservation (Ericsson)
  + Option 2: No (Samsung, Nokia)
  + Option 3: Evaluate the performance for case of symbol-level reservation including the DMRS symbols (Huawei)
* Recommended WF
  + TBA

## Companies views’ collection for 1st round

### Open issues

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| --- | --- |
| **Company** | **Comments** |
| Huawei: | Sub topic 1-1:  Option 1: In case of slot-level reservation, the reserved slot will be dropped including DMRS, We don’t think it has impact on demodulation performance.  In case of symbol-level reservation: the reserved symbols will be dropped, if the reserved symbols includes DMRS, the DMRS symbols can be dropped, too. In such case, the channel estimation will be impacted due to the dropped DMRS symbols. to clearly describe this case, we added Option 3. |
| Samsung | Sub topic 1-1: We support option 2  For subframe level based reserved, NB-IoT transmission will be postponed until the next uplink subframe, there is no impact on BS receiver processing and demodulation performance  Regarding option 3: Most UE are stationary or have low speed deployed in NB-IoT scenario. With DMRS symbol dropped, we don’t think demodulation requirement will be large different with existing requirements, considering the cross-subframe channel estimation could be applied in NB-IoT.  Meanwhile, based on the WF in last meeting, we should focus on the PUSCH requirement in case of postponed by subframes. |
| Ericsson | Sub topic 1-1: We are fine not to define new NPUSCH demodulation requirements for coexistence scenario. We support option 2. |
| Nokia | Sub topic 1-1: We support option 2.  In our view, for option 3 it should be avoided that DMRS symbols fall into LTE-MTC reserved symbols, by NR rate matching around these DMRS symbols. For option 1, if the reserved slot includes DMRS symbols, then DMRS symbols of the paired slot are still available. |

### CRs/TPs comments collection

*Major close to finalize WIs and Rel-15 maintenance, comments collections can be arranged for TPs and CRs. For Rel-16 on-going WIs, suggest to focus on open issues discussion on 1st round.*

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| XXX | Company A |
| Company B |
|  |
| YYY | Company A |
| Company B |
|  |

## Summary for 1st round

### Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*

|  |  |
| --- | --- |
|  | **Status summary** |
| **Sub-topic#1-1** | *Tentative agreements:*  *Candidate options:*  *Whether to introduce BS demodulation requirements for coexistence of NPUSCH and NR*   * + Option 1: No (Samsung, Nokia, Ericsson)   + Option 2: Evaluate the performance for case of symbol-level reservation including the DMRS symbols (Huawei)   *Recommendations for 2nd round:* Continue to discuss about whether to introduce BS demodulation requirements for coexistence of NPUSCH and NR |

*Suggestion on WF/LS assignment*

|  |  |  |
| --- | --- | --- |
|  | **WF/LS t-doc Title** | **Assigned Company,**  **WF or LS lead** |
| #1 |  |  |

### CRs/TPs

*Moderator tries to summarize discussion status for 1st round and provided recommendation on CRs/TPs Status update suggestion*

|  |  |
| --- | --- |
| **CR/TP number** | **CRs/TPs Status update recommendation** |
| XXX | *Based on 1st round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

## Discussion on 2nd round

### Open issues summary

**Issue 1: Whether to introduce BS demodulation requirements for coexistence of NPUSCH and NR in case of symbol-level reservation**

* Proposals
  + Option 1: No
  + Option 3: Evaluate the performance for case of symbol-level reservation
* Recommended WF
  + TBA

### Companies’ view collection for 2nd round

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| --- | --- |
| **Company** | **Comments** |
| Ericsson | Issue 1: We prefer Option 1. We agree with Sumsung’s comment in the 1st round. The existing NPUSCH format 1 demodulation requirements in TS36.104 uses ETU1. We don’t expect the channel estimation impact even if some slots are dropped due to the slot-level UL resource reservation. |
| Huawei | Issue 1: We support option3.  From the companies’ analysis in this meeting, several companies agreed that the channel estimation will be affected for the case of symbol-level reservation, especially when the DMRS symbol is reserved, the corresponding DM-RS symbols also should be dropped, this will significantly change the structure of reference signal used for channel estimation, so the performance will be affected. We think that RAN4 should evaluate the impact to demodulation performance and make conclusion as per the evaluations. The channel estimation by using across-slot estimation is a kind of advanced receiver, this assumption is not considered in the previous performance requirements definition.  To Ericsson and Samsung: we could define a coexistence scenario of NPUSCH and NR in case of symbol-level reservation to evaluate whether it has a performance loss. |
| Samsung | As for channel estimation, either using intra-slot or inter-slot shall be the implementation issue, there is limitation in RAN4. As mentioned by Ericsson, current test case is based on ETU1Hz. Normally, the Doppler is very small, it can regraded as statics fading channel. We donot expect the performance different is very limited even with only 1 DMRS (4th symbol of every 7 symbols). |
| Nokia | Issue 1: We support option 1. We share the views of Ericsson and Samsung with regard to expected low channel estimation impact due to stationary or low velocity character of NB-IoT devices and thus an increased channel coherence time. |

## Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

|  |  |
| --- | --- |
| **CR/TP/LS/WF number** | **T-doc Status update recommendation** |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |